Center Innovation Fund: ARC CIF

Electrochemical Detection of Biological Catalysts as Signatures of Life

Completed Technology Project (2016 - 2017)

Project Introduction

The enzyme trypsin is chosen as a detection target due to its ubiquity in Earth biology. Trypsin catalyzes the break down of proteins through a catalytic triad consisting of histidine, aspartate and serine. The proposed sensor works by the detection of proteolytic cleavage of a redox-active tag. It is comprised of two gold electrodes. The first gold electrode houses a sensor probe, in this case a substrate peptide. The second electrode is a collector electrode that will detect the product of peptide cleavage. A methylene-labeled substrate peptide is self-assembled on a gold electrode using a thiol linkage. Any remaining accessible area of the electrode is then “blocked” or backfilled with an alkanethiol, which acts as an insulator and forces the peptide to stand up and form a close-packed structure on the gold surface. In this close-packed configuration, the peptide is accessible to the catalytic reaction with trypsin. Trypsin cleaves the peptide and releases the methylene blue terminus. A characteristic redox signature of methylene blue is detected at the second electrode using cyclic voltammetry and/or square wave voltammetry. Electrodes will be fabricated as 2 gold band electrodes on an inert substrate using a shadow mask and gold evaporation. While not required for proof of concept sensing, a simple fluidic channel will be added over the electrodes to demonstrate future integration ease with the ARC Universal Sample Processor for Life on Icy Worlds (SPLIce).

Anticipated Benefits

Liquid water is the quintessential ingredient for life. Biochemistry as we know it is not possible without it. There are two places in the Solar System, other than the Earth, where liquid water is known to exist: Europa and Enceladus. Cassini's recent discovery of Enceladus’ ocean plumes has excited the scientific community about the possibility for liquid sampling and search for life. Characteristics of life are self-sustainability, its ability to evolve, and self-enclosure. To enable these, chemical energy must be utilized, information must be stored, and enclosing membranes must be built. Many of these processes are accomplished with the use of biological catalysts. To search for life in the ocean worlds, detection of biological catalysts serves as a strong marker of biological activity and thus life.

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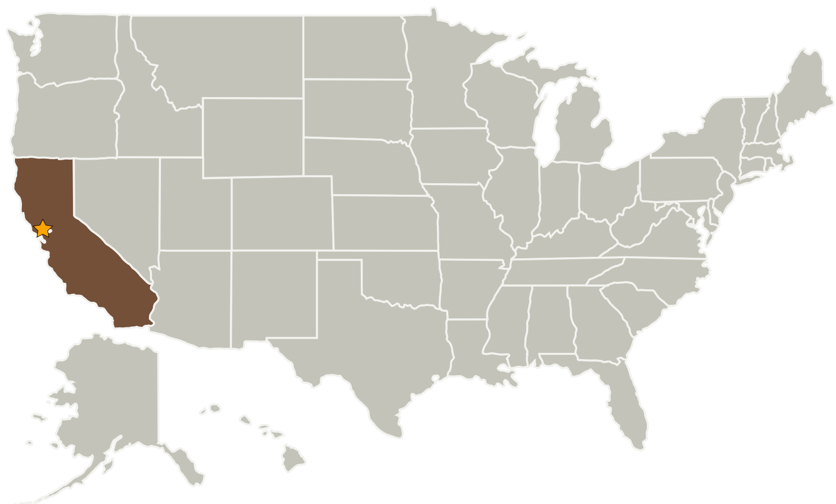
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations
California

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

Center Innovation Fund: ARC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

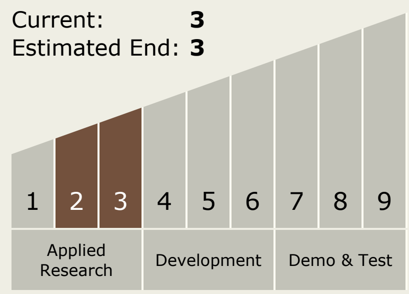
Harry Partridge

Principal Investigator:

Richard C Quinn

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX04 Robotic Systems
  └─ TX04.3 Manipulation
    └─ TX04.3.4 Sample Acquisition and Handling

Target Destination

Others Inside the Solar System